IN THE CLAIMS

1. (Amended) A fiber optic sensor system, comprising:

at least one measuring sensor providing a measuring output dependent upon one or more parameters to be measured;

at least one reference sensor providing a reference output for comparison with the measuring output, said reference sensor being provided in a birefringent fiber, such that said reference output has a plurality of different polarisation planes and frequency components;

detecting instrumentation, said detecting instrumentation being adapted to derive a reference beat signal by measuring an optical frequency splitting between said frequency components, and said detecting instrumentation being adapted also to generate a further beat signal between the measuring and reference sensor outputs;

wherein said system is arranged to derive a measurement of one or more parameters using said reference beat signal and said further beat signal.

2. (Original) A fiber optic sensor system including measuring and reference sensors written into respective optical fibers, in which at least the reference sensor is written into a birefringent fiber, and the system further includes detecting instrumentation which operates by generating a beat frequency derived from the output of the reference sensor.

3. (Original) A system as claimed in claim 1 adapted to use a beat frequency derived from the reference sensor output and a beat frequency derived from a comparison between the measuring sensor output and the reference sensor output to derive an indication of at least one parameter of interest without the need directly to measure the absolute frequency of either sensor by optical means.

4. (Original) A system as claimed in claim 1 wherein the measuring sensor is also provided in a birefringent fiber and the system is adapted to generate a beat frequency derived from said measuring sensor such that the measuring sensor can be used to measure a different parameter.

5. (Original) A system as claimed in claim 1 comprising a plurality of measuring sensors at different nominal wavelengths, said measuring sensors being multiplexed along a common respective fiber with a single reference sensor provided in a different fiber or with multiple reference sensors.

6. (Original) A system as claimed in claim 1 wherein said measuring and reference sensors have the same nominal operating wavelength.

7. (Original) A system as claimed in claim 1 wherein said reference sensor is located in an oven whose temperature is controlled in such a way that the reference sensor has the same nominal operating wavelength as the measuring sensor.

8. (Original) A system as claimed in claim 1 wherein said reference sensor is placed close to the measuring sensor.

9. (Original) A system as claimed in claim 1 wherein said reference and measuring sensors are in the form of a measuring laser and a birefringent reference laser respectively, said measuring and reference lasers being active fiber lasers, wherein an output of said birefringent reference laser comprises spaced spectral peaks in different polarisation planes.

10. (Original) A system as claimed in claim 9 wherein said measuring and reference lasers are fiber distributed feedback lasers.

11. (Original) A system as claimed in claim 9 wherein the measuring laser is also written into a birefringent fiber.

12. (Original) A system as claimed in claim 1 comprising detecting instrumentation arranged to operate by generating beat frequencies in an electrical domain.

13. (Original) A fiber laser sensor system comprising at least two fiber lasers written into respective optical fibers, at least one of which is a birefringent fiber having a birefringence, and detecting instrumentation configured to generate beat signals dependent upon the birefringence of said at least one fiber.

14. (Original) A system as claimed in claim 13 wherein said detecting instrumentation is also arranged to generate beat signals between the laser outputs, such that beat signals can be used to derive a measurement of at least one parameter.

15. (Original) A system as claimed in claim 13 wherein one of said fiber lasers constitutes a reference laser which is located in a separate environment from a measuring laser.

16. (Original) A system as claimed in claim 13 wherein said two fiber lasers are differently configured and are located in the same environment.

17. (Original) A system as claimed in claim 1 wherein at least said measuring sensor is a passive device.

18. (Original) A system as claimed in claim 17 wherein said passive device comprises a passive fiber Bragg grating.

19. (Original) A system as claimed in claim 18 wherein said measuring sensor comprises a π-phase-shifted fiber Bragg grating.

20. (Original) A system as claimed in claim 17 wherein at least the reference sensor is provided in a birefringent fiber having two birefringent axes, said system further comprising a resonance measurer for measuring two resonances corresponding to the birefringent axes of the fiber.

21. (Original) A system as claimed in claim 17 comprising a tunable light source and a comb spectrum deriver for deriving a comb spectrum from a part of the light from said tunable light source.

22. (Original) A system as claimed in claim 21 wherein said comb spectrum deriver comprises an interferometer arranged to receives a part of the light from said tunable source.

23. (Original) A system for spectral analysis, comprising a tunable light source for emitting light, wherein a first part of said light from said tunable light source is arranged to pass to an optical device providing a device spectrum to be measured, and a second part of the light is passed to an interferometer which generates a comb spectrum, said comb spectrum being used to provide a linearised frequency scale for measurement of a device spectrum, whereby the effect of noise in the tunable light source is reduced, and a third part of the light from the tunable light source is passed to a birefringent reference grating which provides an absolute wavelength reference.

24. (Original) A system as claimed in claim 23 wherein said interferometer is a Michelson interferometer arranged to act as a frequency discriminator as well as a comb spectrum generator.

25. (Original) A system as claimed in claim 23 wherein said reference grating is a π-phase shifted fiber Bragg grating.

26. (Original) A system as claimed in claim 23 comprising a part thereof being arranged to carry out a measurement by locking frequencies of additional fiber laser sources to resonance frequencies of said system; and a part thereof for measuring electrical beat frequencies between these laser frequencies.

27. (Original) A fiber optic sensing system comprising at least two passive π-phase shifted FBG sensors written into respective fibers, at least one of which is a birefringent fiber, and detecting instrumentation including instrumentation for measuring the frequency splitting between two resonances of the birefringent fiber, the detecting instrumentation being arranged to derive a reference signal using said frequency splitting.

28. (Original) A system as claimed in claim 27 comprising instrumentation for measuring a frequency splitting between the reference and measuring sensor outputs.

29. (Original) A system as claimed in claim 27 wherein both of said FBG's are written into birefringent fibers.

30. (Original) A system as claimed in claim 29 wherein said detecting instrumentation is additionally configured to measure a frequency splitting between resonances of each birefringent fiber.

31. (Original) Detecting instrumentation for use with a fiber optic sensing system, the detecting instrumentation including analysis instrumentation for receiving and analysing optical outputs from at least two fiber optic sensors, wherein said optical outputs have substantially the same nominal operating wavelength, and at least one of the outputs having birefringent components, the analysis instrumentation being arranged to operate by comparing said optical outputs from said at least two fiber optic sensors to derive an output signal indicative of at least one parameter sensed by at least one of the sensors in use.

32. (Original) A dual parameter fiber optic sensing system, comprising a pair of birefringent optical fibers each having at least one sensor configured to provide a birefringent optical output dependent upon a respective parameter, and detecting instrumentation having signal processing instrumentation adapted to provide an electrical output signal indicative of the birefringence of each of said fiber.

33. (Original) A system as claimed in claim 32 wherein said sensors are configured to operate with substantially different operating wavelengths.

34. (Original) A method of sensing a parameter comprising:

providing a fiber optic measuring sensor having measuring optical output;

providing a birefringent fiber optic reference sensor having a reference optical output; and

comparing said measuring optical output with said reference optical output, wherein said measuring and reference sensors have substantially the same nominal operating wavelength.

35. (Original) A method of sensing a parameter using two or more fiber optic sensors, comprising using an output from a reference sensor provided in a birefringent fiber to derive a beat signal for comparison with an output from a measuring sensor provided in a second fiber.

36. (Original) A method as claimed in claim 35 comprising using a first beat frequency derived from the reference sensor output and a second beat frequently derived from a comparison between the measuring sensor output and the reference sensor output to derive an indication of at least one parameter of interest without the need directly to measure the absolute frequency of either sensor by optical means.

37. (Original) A method as claimed in claim 35 comprising measuring a frequency splitting in relation to the optical output from said birefringent reference sensor thereby providing an indication of temperature of the reference sensor.

38. (Original) A method as claimed in claim 37 comprising comparing said optical output with a frequency component of the measuring sensor and deriving a measurement of temperature at the measuring sensor.

39. (Original) A method as claimed in claim 37 comprising comparing said optical output with a frequency component of the measuring sensor; using said indication of temperature at the reference sensor to correct the output of the measuring sensor for variations in temperature; and, deriving another parameter from the measuring sensor.

40. (Original) A method as claimed in claim 35 wherein the reference sensor has the same nominal operating wavelength as the measuring sensor.

41. (Original) A method as claimed in claim 35 comprising providing said measuring sensor in a second birefringent fiber, and performing a measurement in relation to a birefringent response of said second birefringent fiber, said measurement being based on a spacing of spectral peaks or notches in mutually orthogonal polarisation planes.

42. (Original) A method as claimed in claim 41 comprising comparing said spacing with a birefringent wavelength spacing derived from the reference sensor, and using the reference sensor to calibrate or correct the output from the measuring sensor.

43. (Original) A method as claimed in claim 41 comprising using the absolute frequency of the measuring sensor output for measurements.

44. (Original) A method as claimed in claim 43 comprising:

measuring the absolute frequency of the measuring sensor, the absolute frequency of the reference sensor, and a birefringent frequency splitting of each of said sensors; and determining two parameters, such as pressure, temperature, or biochemical parameters therefrom.

45. (Original) A method as claimed in claim 35 comprising deriving the absolute frequency of the measuring sensor from beats generated between the measuring and reference sensor outputs.

46. (Original) A method of measuring one or more parameters using a fiber optic sensor system, said sensor system comprising:

at least one measuring sensor providing an optical output dependent upon said one or more parameters;

at least one reference sensor providing a reference output, wherein the reference sensor is provided in a birefringent fiber such that said reference output has frequency components in different polarisation planes; and

detecting instrumentation; said method comprising:

deriving a reference beat signal by measuring an optical frequency splitting between said frequency components in different polarisation planes of the reference sensor output;

generating a further beat signal between said measuring and reference sensor outputs; and using said reference beat signal and said further beat signal to derive a measurement of said one or more parameters.

47. (Original) A method of measuring one or more parameters using a fiber optic sensor system, said sensor system comprising:

at least one measuring sensor providing an optical output dependent upon said one or more parameters;

at least one reference sensor providing a reference sensor output wherein the reference sensor is provided in a birefringent fiber said method comprising:

deriving a first beat frequency from the reference sensor output;

deriving a second beat frequency from a comparison between the measuring sensor output and the reference sensor output; and

using said first and second beat frequencies to derive an indication of said at least one parameter without the need directly to measure the absolute frequency of either sensor by optical means.

48. (Original) A method as claimed in claim 46 wherein the measuring sensor is also provided in a birefringent fiber, the method further comprising deriving a beat frequency from said measuring sensor and using said beat frequency to measure a different parameter.

49. (Original) A method as claimed in claim 46 wherein said measuring and reference sensors have the same nominal operating wavelength.

50. (Original) A method as claimed in claim 46 comprising locating said reference sensor in an oven and controlling the temperature of said oven in such a way that the reference sensor has the same nominal operating wavelength as the measuring sensor.

51. (Original) A method as claimed in claim 46 comprising placing said reference sensor close to the measuring sensor.

52. (Original) A method as claimed in claim 46 comprising providing detecting instrumentation and generating beat frequencies in an electrical domain using said detecting instrumentation.

53. (Original) A method of measuring at least one parameter using a fiber laser sensor system having:

at least two fiber lasers written into respective optical fibers, at least one of said fibers being birefringent and having a birefringence; and

detecting instrumentation;

said method comprising using said detecting instrumentation to generate beat signals dependent upon the birefringence of said at least one birefringent fiber.

54. (Original) A method as claimed in claim 53 wherein said at least two fiber lasers have laser outputs, the method further comprising generating beat signals between the laser outputs, and using said beat frequencies to derive a measurement of at least one parameter.

55. (Original) A method as claimed in claim 53 comprising designating one of said fiber lasers as a reference laser and one of said fiber lasers as a measuring laser and locating said reference laser in a separate environment from said measuring laser.

56. (Original) A method as claimed in claim 53 wherein said two fiber lasers are differently configured, said method further comprising locating said two fiber lasers in the same environment.

57. (Original) A method as claimed in claim 35 wherein at least the reference sensor is provided in a birefringent fiber having two birefringent axes, said method further comprising measuring two resonances corresponding to the birefringent axes of the fiber.

58. (Original) A method as claimed in claim 35 comprising providing a tunable light source and deriving a comb spectrum from part of the light therefrom.

59. (Original) A method as claimed in claim 58 comprising measuring spacings between the spectral notches in the birefringent output of the fiber using the comb spectrum as an accurate frequency/wavelength scale.

60. (Original) A method of spectral analysis comprising:

providing a tunable light source; passing a first part of light from said tunable light source to an optical device providing a device spectrum to be measured;

passing a second part of the light from the tunable light source to an interferometer, thereby generating a comb spectrum;

using said comb spectrum to provide a linearised frequency scale for measurement of the device spectrum, whereby the effect of noise in the tunable light source is reduced; and

passing a third part of the light from the tunable light source to a birefringent reference grating, thereby providing an absolute wavelength reference.

61. (Original) A method as claimed in claim 60 comprising providing a Michelson interferometer as said interferometer and arranging the Michelson interferometer to act as a frequency discriminator as well as a comb spectrum generator.

62. (Original) A method as claimed in claim 60 comprising carrying out a measurement by locking laser frequencies of additional fiber laser sources to resonance frequencies of said system and measuring electrical beat frequencies between said laser frequencies.

63. (Original) A method of sensing using:

at least two passive π-phase shifted FBG sensors written into respective fibers, at least one of which is a birefringent fiber; and

detecting instrumentation;

the method comprising:

measuring a frequency splitting between said two resonances of the birefringent fiber; and

said detecting instrumentation using said splitting to derive a reference signal.

64. (Original) A method as claimed in claim 63 comprising measuring a frequency splitting between the outputs of said two passive π-phase shifted FBG sensors.

65. (Original) A method as claimed in claim 63 wherein both of said passive π-phase shifted FBG sensors are written into birefringent fibers, each having two resonances, said method further comprising measuring the frequency splitting between the resonances of each birefringent fiber.

66. (Original) A method of deriving an output signal indicative of at least one parameter comprising:

providing at least two fiber optic sensors providing optical outputs with substantially the same nominal operating wavelength, at least one of said outputs having birefringent components;

receiving and analysing said optical outputs; and

comparing said optical outputs to derive said output signal indicative of the at least one parameter.

67. (Original) A fiber optic sensor system, comprising:

at least one measuring sensor providing a measuring output dependent upon one or more parameters to be measured;

at least one reference sensor providing a reference output for comparison with the measuring output, said reference sensor being provided in a birefringent fiber, such that said reference output has a plurality of different polarisation planes and frequency components;

detecting instrumentation, said detecting instrumentation being adapted to derive a reference frequency difference signal by measuring an optical frequency splitting between said frequency components, and said detecting instrumentation being adapted also to generate a further frequency difference signal between the measuring and reference sensor outputs;

wherein said system is arranged to derive a measurement of one or more parameters using said reference frequency difference signal and said further frequency difference signal.